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APOLLO MONTHLY PROGRESS REPORT (U)

NAS9-150

April 1, 1965

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Report Period
February 16 to March 15, 1965

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ABSTRACT

Brief, illustrated narrative report of Apollo program progress for the period, highlighting accomplishments, milestone achievements, and a continuing summary of the program

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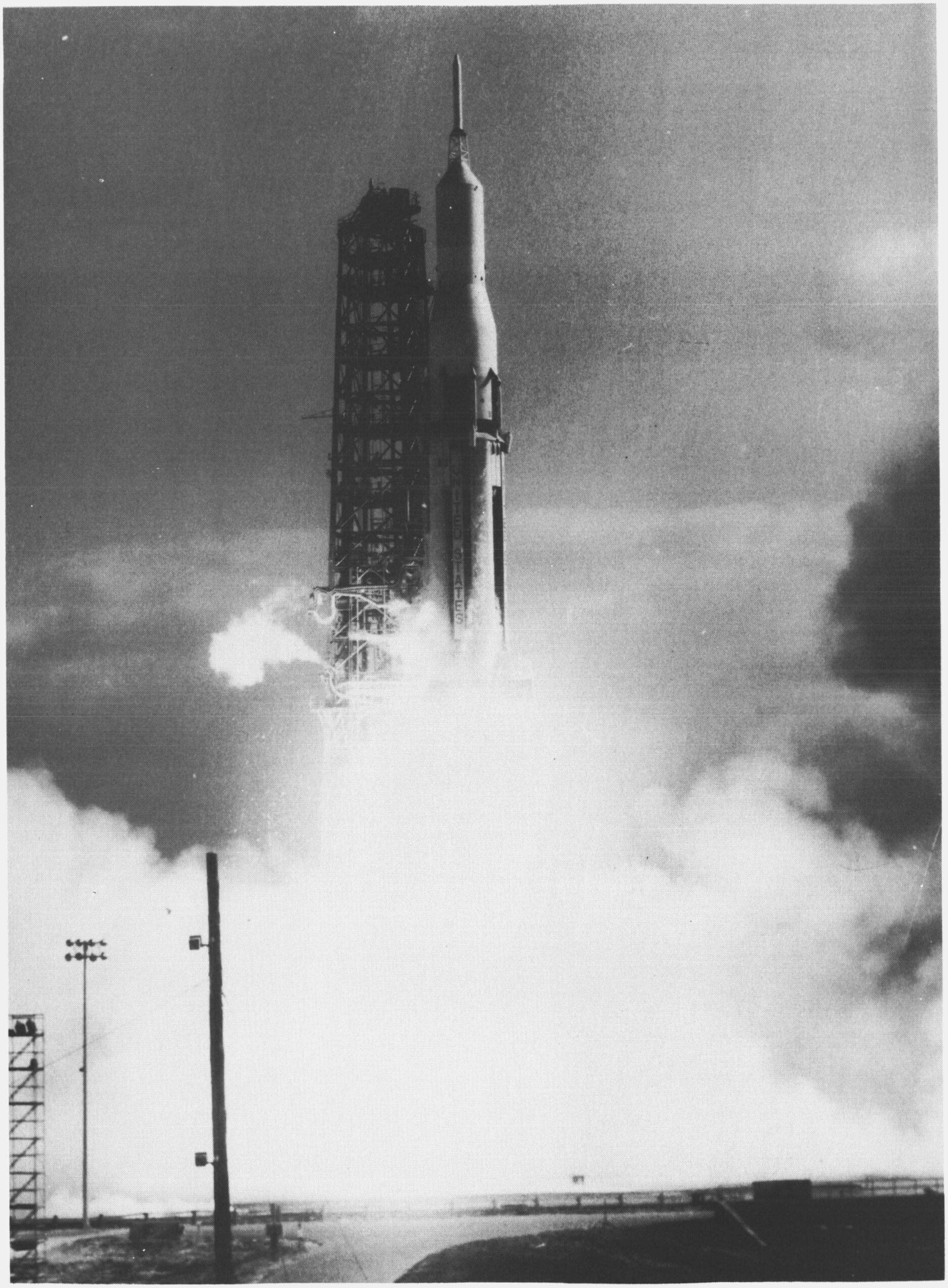

KSC-63-BP16-36

Figure 1. Boilerplate 16 Launch

PROGRAM MANAGEMENT

STATUS SUMMARY

Spacecraft Testing

Apollo boilerplate 16 was successfully launched at 9:37 a.m. on February 16, 1965 (Figure 1). Mission A-103, using the Saturn SA-9 launch vehicle, was the first micrometeoroid experiment, an orbital flight to determine the magnitude and direction of intermediate meteoroids in near-earth space. Satisfactory operation of all pyrotechnic devices was indicated by successful tower jettison at T + 158.1 seconds. The detection device ("Pegasus") deployed at T + 881.3 seconds. The apogee of the orbit is 744.5 nautical miles (NM); the perigee is 497.3 NM.

Manufacturing

All interior secondary-structure installations for the command module of spacecraft 009 were completed during the report period, and final inspection of the interior primary structure was completed and accepted by NASA on Feburary 19.

Inner structure welding operations of the command module of spacecraft 011 and joining of the forward and aft inner structure sections were also completed February 19.

The heat shield and inner structure fit check operations for the command module of spacecraft 008 were completed and accepted by NASA on March 10. The apex, forward, crew compartment, and aft heat shields are being prepared for shipment to Avco for application of ablative material.

Installation of all interior secondary-structure bays on the command module of spacecraft 006 was completed and accepted by NASA February 27. NASA acceptance of the spacecraft 006 command module structure was completed March 12, and the module was transferred to the systems integration and checkout facility for installation of simulated masses in support of quality verification vibration testing (QVVT).

Integrated system checkout operations for boilerplate 22 were completed March 7, and final configuration updating and shipping preparations were completed on March 15.

Subsystem Deliveries

On February 19 the first guidance and navigation subsystem was delivered to the guidance and control group of S&ID.

DEVELOPMENT

SYSTEM DYNAMICS

Aerodynamics

A study was completed to define the three-sigma dispersion at launch escape subsystem (LES) jettison for the Saturn IB and Saturn V boost vehicles. These data will be used to define the loading on the spacecraft-lunar excursion module adapter panels. The maximum dynamic pressure for the three-sigma Saturn IB trajectory is 0.75 psf. To support the design effort for the deployment and attenuation subsystem of the spacecraft-lunar excursion module adapter panels, the expected hinge moments were developed for conditions corresponding to 1 psf dynamic pressure.

Test points were selected to support a proposed demonstration of command module apex cover jettison in conjunction with the El Centro parachute drop test. The selected points are representative of the more difficult apex cover jettison situations. Both short- and long-term separation of the apex cover are considered acceptable for the proposed demonstration.

Pyrotechnics and Earth Landing Subsystem (ELS)

The minimum-airworthiness test of the tower sequencer for boilerplate 22 was completed on February 19. The unit successfully passed temperature, resonance, and vibration testing (in three axes), acceleration, and final complete functional tests. Test results are being analyzed.

In mortar firing tests at Northrop Ventura, high breech pressures were encountered with a new lot of drogue mortar cartridges. Additional tests showed that cartridges loaded with the new orifice initiators apparently gave better ignition and flame penetration. The flame penetrated through the cartridge and ignited the diametrically opposed cartridge with sufficient vigor to cause the cartridge to explode. Corrective steps are being taken to insert a baffle between the initiator and pellet charge in the cartridge. This is done to take advantage of the improved initiator and yet prevent the flame from projecting through to cause sympathetic ignition at extremely high pressures.

Drop test 79, using a parachute test vehicle and a B-66 drop aircraft, was completed at El Centro to demonstrate structural integrity of the drogue chutes at disreef ultimate load. The drop was also performed to observe operation of a Block I main chute packed to a density of 0.023 pounds per cubic inch. Maximum drogue chute loads well in excess of the required 17,100 pounds were measured, and the main chute operated satisfactorily.

Drop test 80 was conducted at El Centro to demonstrate the disreefed ultimate load capability of the main chute deployed from the 0.023-pound per cubic inch density pack. Measurements indicated that the chute successfully sustained the required 34,800 pounds prior to burst when the loads exceeded this value.

Water impact tests 92 and 93 were performed with boilerplate 28 at the S&ID drop test facility. The primary objective of test 92 was to exceed the calculated shear capability of the heat shield without subsequent leakage, following a simulated normal two-chute descent. Preliminary analysis of test data indicated that desired impact conditions were achieved and peak pressures were as anticipated. Slight deformation of the heat shield stiffeners in the toroidal section was observed, but there was no leakage. The primary objective of test 93 was to exceed the calculated minimum face sheet limit load without subsequent leakage, following a simulated severe three-chute descent. The probability is that these conditions will occur once in 10,000 landings. Preliminary analysis of test data indicated that all objectives were fulfilled and no leakage was observed. Test conditions were as follows:

V_N (normal velocity)	= 35 fps
V_H (horizontal velocity)	= 40 fps
Pitch	= -17 deg
Roll	= 180 deg

Drop tests have lifted all spacecraft 009 flight constraints relating to the strength of the aft heat shield.

MISSION DESIGN

The mission-spacecraft compatibility evaluation for spacecraft 009 was completed. The extent of the evaluation was limited because of the lack of certain pertinent trajectory data. The NASA "Preliminary Reference Trajectory" was used as a basis for the evaluation. The study indicates that while the spacecraft subsystems are compatible with the normal mission to the extent evaluated, the present automation of service module aborts is not compatible with service module abort trajectories from the nominal powered trajectory.

A detailed analysis of revised propellant requirements for the Block II service module reaction control subsystem (RCS) was made to determine the impact of revised subsystem performance and mission maneuver requirements on the service module RCS. The required mission maneuvers are tentatively to be instituted within the command and service module technical specification. The propellant necessary to perform these maneuvers, with present specification control weights and RCS engine performance, is 913 pounds. Conclusions from this analysis indicated that the following recommendations should be adopted:

1. Revision of the spacecraft maneuver requirements to be defined in the command and service module technical specification to remove the small ΔV requirements imposed on the RCS (5 fps translunar and 15 fps transearth). Trajectory error and guidance analysis indicate that these requirements can be removed.

2. Implementation of operational capability for single jet per axis attitude hold

3. Propellant budgeting for spacecraft orientations based upon the performance of these maneuvers in the automatic mode, the three-axis orientations to be accomplished by a roll-pitch-roll or roll-yaw-roll sequence

4. Budgeting the contingent propellant for quad failure, lunar excursion module rescue, and manned space flight network (MSFN) failure by the root-sum-squared method

5. Not resizing the present service module RCS

6. Acceptance of an 18-second degradation in service module RCS I_{sp}

7. Delineation of control values for vehicle mass moments of inertia in the command and service module technical specification

The trade-offs of service module RCS propellant which are applicable to the recommendations listed are as follows:

1.	Increased lunar excursion module weight and gross spacecraft weight	+28 pounds
2.	RCS I_{sp} reduced by 18 seconds	+55 pounds

3. Removal of service module small ΔV requirements — -156 pounds

4. Instituting of single jet per axis attitude hold — -82 pounds

Adoption of these trade-offs would reduce the service module usable propellant requirements to 758 pounds, a quantity which includes 10 percent excess for unaccounted factors.

A study was made of various entry profiles which could be used for SA501 and SA502 to flight-verify the heat shield for manned Block II flights. Considerations included the following:

1. Flight verification heat load

2. Flight verification heat rate

3. Instrumentation requirements

4. Backup vehicle requirements

The following heat shield verification criteria evolved from the study:

1. A flight verification trajectory should yield a heat load which approximates the Block II design trajectory heat load. The heat load should be sufficiently large that extrapolation to the design heat load can be done with a reasonable confidence level.

2. A flight verification trajectory should yield a heat rate which approaches the heat rate obtained from an entry at 36,333 fps and which achieves a g-level somewhat in excess of 10 g's during the initial entry phase, rather than the 20-g Block II heat shield design trajectory heat rate. The heat rate selection was based upon the backup transearth and midcourse guidance corridor of 23 NM and a maximum g-level of 10.

3. The instrumentation should be the same for all verification flights.

Two approaches were considered for flight verification of the heat shield for manned Block II missions. The first was to fly two separate successful missions, one to achieve a high heat rate and the other to achieve a high heat load. The second approach was to fly a single successful mission which would achieve both a high heat rate and a high heat load. The second alternative was selected because it required one less backup vehicle.

The NASA profile (PS3-65-42) was examined for suitability for flight verification. To avoid heating rates and loads too low to flight-verify the heat shield, the recommended trajectory profile enters at a speed higher than nominal lunar return and achieves heating rates and loads which satisfy the heat shield verification criteria. Approximate target trajectory conditions include an entry velocity of 37,300 fps, an initial entry maximum g-level of 7, and an entry range of 2500 NM.

CREW SUBSYSTEM

First results of zero-g testing with the zero-g waste management subsystem test fixture at Wright Patterson AFB indicate successful operation. Prequalified spacecraft equipment simulated actual spacecraft gaseous flow rates and pressure differentials. The subsystem successfully contained solid and liquid wastes. The urine disposal lock was successfully tested; there was no leakage under maximum-capacity conditions.

The emergency environmental cell and an S&ID test subject were also subjected to zero-g testing at Wright Patterson AFB. The test subject was able to enter and close the 28-inch (diameter) cell successfully, don the Apollo pressure garment assembly, and exit from the cell.

Mock-up food packages were stowed in a box in the lower equipment bay during a test to determine how the food packages would fit the size and shape of the space provided. The allocated space accommodated a four-day food supply; much space, however, was wasted in the upper portion because of the irregular shape of the box. It was agreed that the packs could be in preplanned, shaped, one-meal groups.

Evaluations of subsystems and test subject candidates were started to determine biomedical requirements. Candidates are being screened for the environmental control subsystem (ECS) breadboard studies and for other critical manned tests.

STRUCTURAL DYNAMICS

Additional tenth-scale model flotation tests were conducted to investigate the uprighting capability of the air bag subsystem. Results from the Stevens tests in January and February showed that two 20 to 25 cubic foot bags would upright the vehicle provided that a Y-axis bag was deployed first, followed by another Y-axis bag or a Z-axis bag. Since the requirement for a specific bag deployment sequence implies a lowered subsystem reliability, the desired subsystem should upright with two bags in any order. Recent model tests have used three 25 cubic foot bags; results thus far are good. The model was modified slightly from the Stevens test configuration in order to give better simulation of flooding in the aft skirt area. For an X_{cg} at 41.2 inches and a Z_{cg} at 3.5 inches, the command module will upright itself from the second stable position upon deployment of any two bags in any sequence. Additional tests are planned to cover a range of center of gravity and weight conditions.

FLIGHT CONTROL SUBSYSTEM

Guidance and Control

The guidance and navigation (G&N) AGE-6 subsystem test was completed at AC Sparkplug. The system has been installed in the lower equipment bay mock-up in the S&ID guidance and control laboratory in support of scheduled compatibility and installed-subsystem tests.

An analog computer was used in conjunction with stabilization and control subsystem (SCS) attitude and rate gyros to conduct closed-loop simulation tests of a midcourse maneuver. The purpose of the test program was to verify that the gyros (sensors) will give the same results with simulated gyro electronics as with SCS electronics. Results are being analyzed, and a report is being prepared.

An evaluation of the G&N installation equipment and procedures was initiated; the G&N equipment handling set, the G&N system mock-up (AGE-5A), and the manufacturing command module mock-up are being used.

Flight Subsystem Analysis

The study of transearth injection pointing accuracy for the SCS ΔV mode has been completed. The purpose of the study was to determine whether a reduction of accuracy requirements could be made because of changed entry survival corridor size. Results showed that the transearth injection point accuracy requirement must remain at 1 degree rms to provide a ΔV reserve for the following reasons:

1. To offset the effect of degraded sextant accuracy of 30 arc seconds rms when onboard optical navigation is used with the SCS ΔV mode

2. To avoid the need for additional RCS propellant and for a minimum-impulse mechanization in the SCS to execute transearth midcourse corrections with the SPS minimum-impulse capability using SCS and manned space flight network navigation

Transposition and lunar orbital preliminary stability boundaries for capture latch have been established.

Automated Control

The two phases of interface testing of the mission control programmer (CP) breadboard for spacecraft 009 were completed successfully. The first phase included CP/SCS testing. This test verified that SCS body-mounted attitude gyros can be successfully torqued by means of the CP current generator. The second phase included CP/radio command equipment testing. The evaluation of test results indicates that no interface problems exist.

The mission evaluation study for spacecraft 009 was completed on February 26. Failure studies were conducted during the last phase. Preliminary information indicates that most SCS failures can be detected and overcome by means of ground control; this allows satisfactory completion of spacecraft 009 mission objectives.

TELECOMMUNICATIONS

An off-limit test was performed on a section of the substructure of the aft heat shield (Figure 2). The purposes of the test were to verify the accuracy of the bond-line thermocouples and to prove that the installation of instrumentation did not degrade the structural integrity of the heat shield. Preliminary results indicate that both objectives were met satisfactorily.

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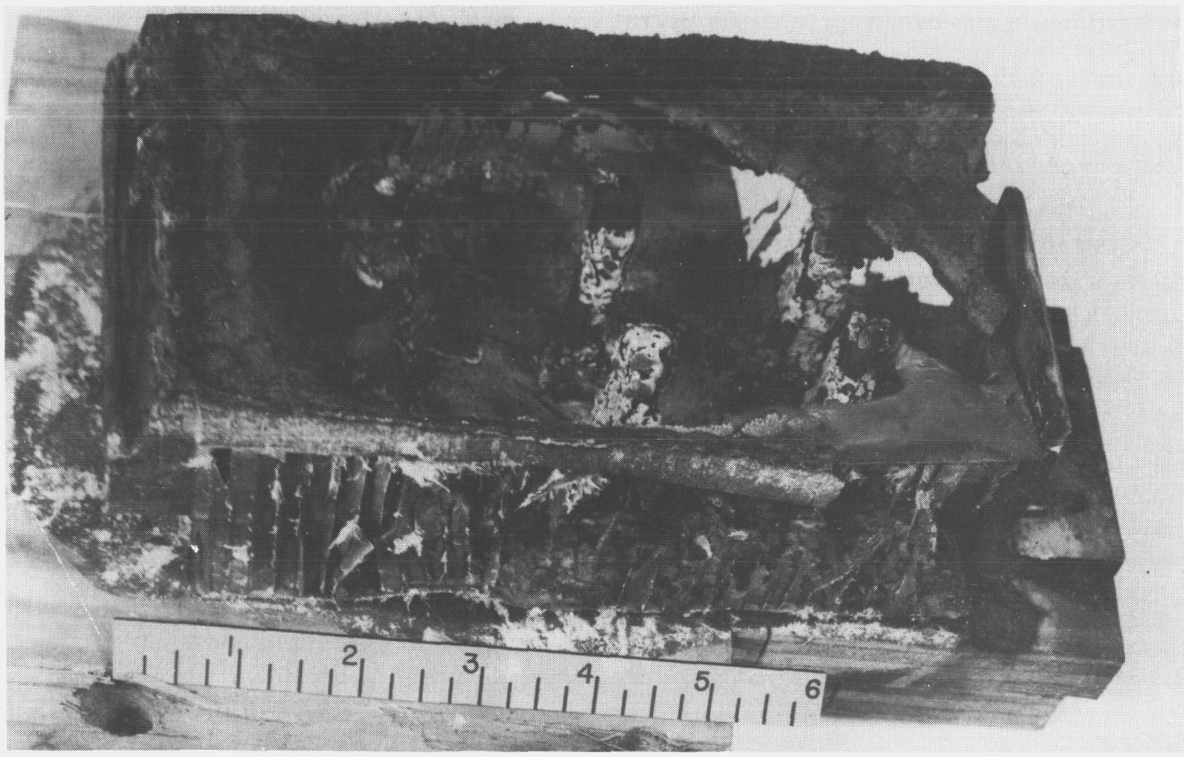

Figure 2. Section of Structure of Aft Heat Shield

The performance and interface specification for the GFE (Block II) TV camera has been negotiated and accepted by NASA with minor changes. A requirement request was completed, defining quantity and need dates for Block II cameras.

The acceptance test of the flight qualification recorder for spacecraft 009 was successfully completed, and the unit was shipped on March 1. Acceptance tests were successfully passed during this report period on the Model D-Z Data storage equipment, and the D-1 models of the PCM telemetry unit, audio center equipment unit, and C-band transponder.

ENVIRONMENT CONTROL

As a result of coordination, incompatibilities between the water management subsystem and fuel-cell ground operation pressures were resolved. It was decided to include a nitrogen supply subsystem for tank pressurization. This pressurization will be from a 900-psi nitrogen source rather than the cryogenic oxygen source. Small changes in the oxygen pressure regulator will permit its use as a nitrogen regulator and will permit the use of an oxygen surge tank as the nitrogen vessel.

The Block I radiator panel assembly was completed and is now ready for testing on the ECS breadboard.

Test coldplates of the pin-fin configuration (with pin-shaped turbulators) have been completed. They will be used for heat-transfer tests during which effectiveness of equipment bolt-down techniques and varying thicknesses of interface grease will be considered.

Laboratory tests have established that 37.5 inches of 0.019-inch inside diameter (ID) tubing, coiled around and bonded over a 6.5-inch length of 0.375-inch outside diameter (OD) tube, will be required for the oxygen heat-exchanger restrictor. The performance of this specimen is now being determined over a range of oxygen and glycol temperatures, pressures, and flows.

A request for an engineering change proposal concerning the low-energy (1 to 30 mev) portion of the design solar flare incident integral spectrum has been received from NASA. The design flare will now be represented by three equations for energies greater than 1 mev. Two rigidity equations represent the spectrum down to 10 mev; a power-law equation represents the spectrum from 1 to 10 mev.

A thermal analysis was performed on the pilot mortar, drogue mortar, main chute disconnect, dual drogue disconnect, and heat shield thruster pyrotechnic devices for the spacecraft 009 evaluation reentry trajectories. The analysis included the effects of gap heating and convective heating following removal of the forward heat shield. None of the devices exceeded the maximum operating temperature limitation of 200 F.

In support of stress analyses, service module shell temperature histories and temperature differences across the shell honeycomb under the boost protective cork were analyzed for Block I vehicles using the Saturn IB boosters. The maximum temperature difference was 108 F.

Entry heating rates and shear stresses were computed at 181 locations on the attached-flow area of the command module during entry for the Block II maximum heating load design trajectory. The maximum convective and radiative heating rates were estimated as 652 Btu/sq ft sec and 1795 Btu/sq ft sec, respectively. The maximum loads were estimated as 62,140 Btu/sq ft and 19,830 Btu/sq ft, respectively.

ELECTRICAL POWER

The fuel cell power plant qualification test at Pratt & Whitney began on February 22 and is proceeding on schedule. The initial restart and acceleration test was completed for qualification test power plant P650717. Qualification test power plant P650718 completed the cold-soak test and performance check. This power plant is undergoing the humidity test. Testing of development power plant X398-13 at Pratt & Whitney was completed for over 1000 hours of operation on load. This run included vacuum operation to the qualification test load profile as well as restart and transient testing.

Structural problems in the hydrogen tank vent valve have been attributed to high stress induced when the vent tube was welded to the vent disconnect. A corrective attachment fitting has been designed and authorized for incorporation into all hydrogen tank assemblies.

Preliminary data from testing by Beech Aircraft of a cryogenic oxygen tank indicated that the high-pressure fill concept resulted in an increase in stored oxygen of 19 pounds per tank. One breadboard cryogenic oxygen tank has been received from Beech (Figure 3).

New load analyses were completed for spacecraft 011. Results show that entry battery capacity is inadequate and fuel cell voltage is too low at maximum load conditions because of recent load additions, such as instrumentation (for service module and heat shield) and the postlanding flotation subsystem. The addition of extra batteries to supplement postlanding battery energy has been requested. The additional batteries will be controlled by the mission control programmer. Shipment of qualified 25-ampere-hour batteries to S&ID began in early March.

The launch escape tower umbilical connectors failed qualification testing at the 15-degree lanyard-pull test. Subsequent analysis revealed that a 10-degree pull will be more than adequate to satisfy requirements.

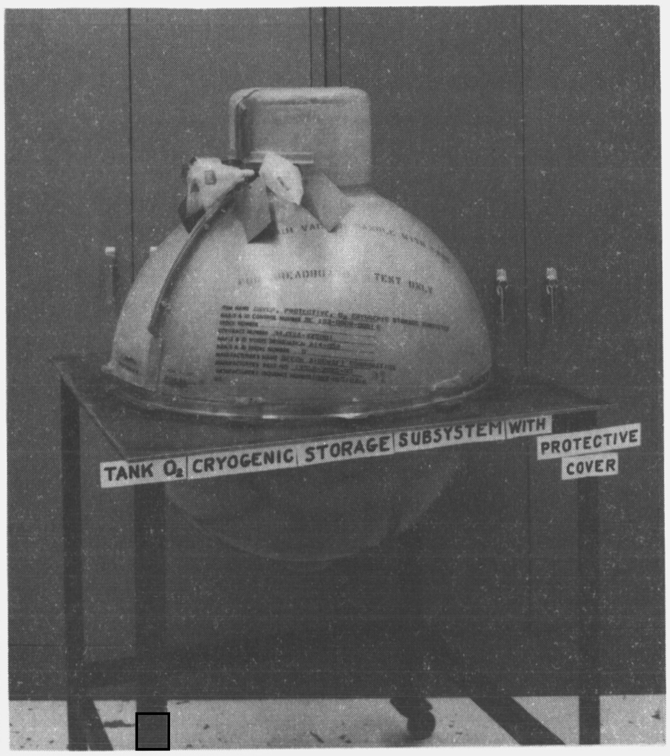

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Figure 3. Breadboard Cryogenic Oxygen Tank

The specification will be changed accordingly. New samples are being manufactured so that testing can be resumed.

Block II electrical power subsystem configuration changes were the subject of a critical design review on February 17. The changes agreed upon are now being implemented as a part of the basic Block II design.

PROPULSION

Service Propulsion Subsystem (SPS)

Production detail drawings for the propellant-retention screen assemblies for spacecraft 012, 014, 017, and 020 are completely released. The engineering for updating of the SPS test fixtures with flight-type hardware is also released. The helium pressure regulator design has been revised to require 350 psig minimum usable inlet pressure instead of the 1800 psig now in effect for spacecraft 009. This design revision is applicable to vehicles subsequent to spacecraft 009 and was caused by the difference in mission requirements.

The engine fuel line flexible connector successfully completed qualification and off-limit testing. The AEDC Phase II simulated high-altitude engine test program continued with seven firings on engine 009. These were combined mixture ratio survey and gimbal-actuator tests. A total of 79 test firings were made at Aerojet General in Sacramento during this report period.

Reaction Control Subsystem (RCS)

A taped mission duty cycle firing of the RCS service module breadboard was successfully completed on February 22. The duty cycle duration was approximately 10 minutes. The test consisted of subsystem activation, pretest hot firing, mission duty cycle, and post-test hot firing.

Qualification testing of the service module relief valve was completed at Calmec on February 26. Pressure regulator acceptance tests continued at Stratos. Two regulators were shipped to S&ID on February 18; this completed the requirements for spacecraft 009. Testing of three additional units was completed, and the units are ready for end-item documentation. Two of these are for the acoustic test panel, and the third is for the command module Phase III breadboard.

Launch Escape Subsystem (LES)

Investigation of the 0.215-second ignition delay of a qualification tower jettison motor is continuing. NASA directed that the qualification program be stopped until the problem is resolved. A joint S&ID-NASA review, held at Thiokol in February, failed to isolate the probable cause of failure. A test program was started in an attempt to duplicate the ignition delay. In 15 firings, the ignition delay has not reoccurred.

Propulsion Analysis

Analysis of the command module RCS propellant loading has been completed; it indicates a loading-time requirement of approximately 10 minutes per tank (with or without the liquid side vents). The recommended ullage back-pressure during loading is 30 psig. The analog study was completed on the pressure regulator for the SPS engine valve actuator. Results show that the SE-5 regulators will meet operational requirements.

The descriptions of the service module RCS engine thermal control subsystems for Block I and Block II vehicles were presented to NASA on February 23. NASA concurred with the general subsystem description and operating procedures but requested additional information concerning some components in the design.

GROUND SUPPORT EQUIPMENT (GSE)

The tapes, cables, and patchboards for the spacecraft instrumentation test equipment (SITE) were completed to support the acceptance checkout equipment (ACE) subsystem tests. The new single-channel decommutator which was required for Grumman and ACE was delivered by Radiation Inc., to support integration testing at Autonetics of subsystems 3 and 4. The compiler program, which allows automated design of SITE patchboards, was completed.

The nozzle extension-firable simulators (Figure 4), serial numbers 1 and 2, were calibrated at the Los Angeles Division of NAA. Number 1 was sent to the propulsion system development facility at WSMR to support spacecraft 001. The delivery of strength calculations to NASA completed the package of calculations requested, which included stiffness analysis and mass-measurement process specifications.

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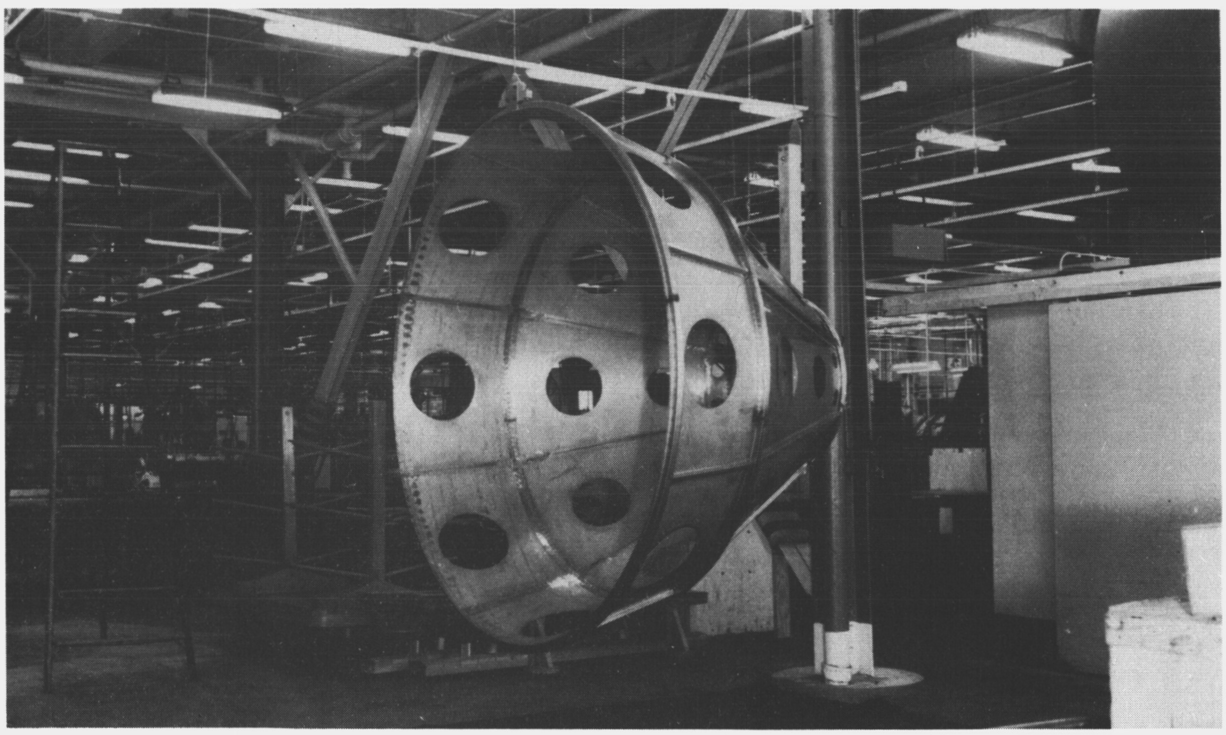

Figure 4. Nozzle Simulator

The electrical terminal distribution junction box for support of boilerplate 22 at WSMR was accepted by NASA on February 24. Installation at the test site has begun.

The service room junction box and the high-bay junction box were delivered to the systems integration and checkout facility, and patching has started. Patching wire lists were released for both J boxes. The first units of the mobile data recorder and the spacecraft ground power supply were accepted by NASA and delivered to the checkout facility. The mobile data recorder will be used on spacecraft 009; the power supply is scheduled for use on boilerplate 14.

The following models of GSE were delivered to the location indicated.

Model No.	Nomenclature	Location
A-14-208	Simulator, nozzle extension-firable	PSDF
C-14-075 (-201)	Propulsion subsystem fluid checkout unit	Integration and checkout facility
C-14-316	Spacecraft ground power filter (two mock-up units)	MSFC
C-14-141	S-band equipment BME	Integration and checkout facility
C-14-142	C-band transponder BME	Integration and checkout facility
C-14-143	Communication equipment BME	Integration and checkout facility
C-14-405	Spacecraft instrumentation test equipment	Integration and checkout facility
C-14-407	Central timing equipment BME	Integration and checkout facility
H14-118	Container, shipping, LO_2 cryogenic storage tank	Integration and checkout facility
H14-119	Container, shipping, LH_2 cryogenic storage tank	Integration and checkout facility
S14-003	Mass spectrometer, leak-tested, helium	Integration and checkout facility
S14-019	Water-glycol service set	Integration and checkout facility

Model No.	Nomenclature	Location
A14-074	Electrical load bank	Integration and checkout facility
C14-476	Fluid distributor subsystem control unit, LH_2	Florida facility (cryogenic facility)
C14-577	Fluid distributor subsystem control unit, LO_2	PSDF
C14-477	Fluid distributor subsystem control unit, LO_2	Integration and checkout facility
A14-062	Adapter, launch vehicle subsystem unit	Florida facility (spacecraft 009)

RELIABILITY

Evaluation was made of the effect on mission success reliability caused by an increase in the minimum mission objectives from the present 2-hour minimum lunar stay period to the nominal lunar stay period of 34.7 hours. The design of S&ID's current model considers the 34.7-hour lunar stay period; however, if an abort is required after a 2-hour lunar stay period and it is safely accomplished, it is not considered a degradation of the mission. This evaluation indicated that a 15.6 percent increase in the mission success reliability objective is required for the command and service module in order to meet its mission objective of 0.9638. (The overall failure rates of the command and service modules must be improved by this 15.6 factor.) Individual subsystem reliability objectives would require corresponding improvement of 0.5 to 28.6 percent, depending upon the effects of the additional mission success time on their respective utilization.

Mission success logic diagrams for the electronic subsystems were completed and integrated into a combined electronics subsystem for the lunar orbital rendezvous (LOR) design reference mission (DRM). Operational similarity between several mission phases permitted the mission success logic to be reduced to three major phases: (1) launch through translunar injection, (2) translunar injection through lunar orbit injection, and (3) lunar injection through end of minimum lunar stay of the lunar excursion module.

A prediction analysis of mission success reliability was performed on the combined electronic subsystem to determine the subsystem's reliability at the end of minimum lunar stay (2 hours), utilizing the Block II LOR design reference mission. The analysis was based on a revised electronic Block II configuration logic, new utilization rates, and updated failure rates. The predicted mission success reliability at the end of minimum lunar stay was 0.96945. The apportioned mission success reliability for the DRM of the combined electronic subsystem is 0.97851. A reevaluation of mission success requirements and equipment utilization rates is being made to increase the predicted reliability to this value.

SPACECRAFT DEVELOPMENT ANALYSIS AND INTEGRATION

As a follow-on to the NASA-S&ID test requirement review of January, four related volumes were compiled of review results and certification requirements for the Block I vehicles. These volumes, identified as the "NASA-S&ID Test Requirements Report" (SID 65-120) and three Certification Test Networks (CTN) covering spacecraft 009, 011 and 012, contain more than 3000 pages of technical data delineating the significant aspects of the Apollo Spacecraft Test Program. Ten copies were transmitted to NASA-MSC on March 3, 1965 for review and comment.

It is intended that the CTN's be used as a noncontractual test requirement baseline of sufficient depth to permit NASA surveillance and direction over the overall test program. The "Command and Service Module Technical Specification" and the subsystem development plans currently cover the test program. Periodic upgrading of the CTN's is planned in order to maintain a current source for test data. Changes to the CTN's will be done formally so that change procedures can be properly initiated.

The total Block I spacecraft program is represented by these three Certification Test Network documents. A similar effort will be applied to the Block II spacecraft test program.

The preliminary basic ground operations requirements plan (GORP), Block I (SID 65-301), was completed and distributed on March 10. This document describes the checkout requirements, sequences, and equipment for conducting the prelaunch tests and preparation for the basic spacecraft from factory to liftoff. The plan incorporates the results of the GORP review held at Ellington AFB in early January.

The development plan for the launch vehicle emergency detection subsystem (LV-EDS), SID 64-2062, was published and distributed on March 1. This plan defines the analyses, design, and testing required to integrate those elements of the LV-EDS contained in the command and service module; the plan encompasses both Block I and Block II requirements.

A preliminary feasibility and conceptual design study for incorporation of an air lock into the Block I command module was made. It was concluded that it would be feasible to incorporate an air lock into the side access hatch covers. The design concept involves development of a substitute inner side access hatch cover and a substitute panel to replace the window of the outer access hatch cover. The air lock would be capable of exposing scientific experiments approximately 6 inches in diameter to the space environment outside the ablator mold line of the command module.

The alternate or substitute hatch concept allows development of the air lock provisions without jeopardizing the basic command module design, development, and fabrication. In addition, the air lock provisions can be selectively installed on only those spacecraft where the air lock capability is required.

VEHICLE TESTING

Ground Test Vehicles

The preparation of spacecraft 006 for quality verification vibration testing (QVVT) is more than 90 percent complete. Simulated masses are being installed. SPS tanks are installed, and the command and service modules are in the test fixture. Six thrusters required for QVVT were delivered together with the necessary amplifier and control equipment. This equipment has been installed and is now in final checkout.

OPERATIONS

DOWNEY

Boilerplate 14

Sequencer subsystem checkout was accomplished in preparation for integrated system test 2. Stabilization and control subsystem (SCS) power checks were completed, and the SCS packages were installed. The monitor wiring installation for determining electromagnetic compatibility within the boilerplate was completed on February 19.

Integrated system test 2, begun on February 22, was completed on March 11. Sequencer performance during the test was satisfactory. Preparations were then started for the acoustic tests to be conducted on the boilerplate 14 command module with all holes in the command module sealed. Special acoustic measurements made in the command module indicated that the decibel and frequency characteristics were within the biomedical requirements for manned testing.

Boilerplate 22

A rerun of the earth landing subsystem (ELS) baroswitch checkout, required because of wiring changes, was completed. The instrumentation subsystem checkout was completed on February 19.

A dry run of the integrated system checkout was completed on February 23. At the end of the dry run, during resetting, the ELS sequencers were subjected to excessive current that required replacement of the sequencers. A design change (required to prevent recurrence of this event) was made, engineering orders were worked on the GSE, and new ELS sequencers were installed. The subsequent integrated system test was completed satisfactorily, and preparations were initiated for shipment of boilerplate 22 to White Sands Missile Range (WSMR).

Reaction Control Quads (Spacecraft 001)

All preshipment testing of the reaction control subsystem engine quad C was completed.

WHITE SANDS MISSILE RANGE

Test Fixture F-2

Four tests (2 through 5 of test series 2) were conducted with test fixture F-2. Test 2 (three 30-second firings) and test 3 (two 30-second and one 120-second firing) were conducted on February 18. A rough combustion cutoff was received on the first firing of test 2 because of a faulty instrumentation signal. All test objectives of both tests were attained.

Test 4, conducted on February 25, consisted of 6 consecutive 5-second firings separated by intervals of 5 seconds. A rough combustion cutoff was experienced at test initiation. Some minor damage to the heat shield boot was sustained from flashback fires apparently caused by the short interval between firings. Examination of data showed that all test objectives were accomplished.

Test 5 was scheduled for 5 firings of 5 seconds duration each, separated by intervals of 55 seconds. Effort to accomplish test 5 on March 4 was discontinued when two attempts to conduct the third firing of this test sequence were terminated by the rough combustion cutoff subsystem. Because an investigation of the rough combustion cutoff subsystem did not indicate a subsystem malfunction, the rough combustion cutoff accelerometer range was increased from 120 g's and 40 milliseconds time delay to 180 g's and 60 milliseconds as a special test condition. In addition, the engine actuator orifices were changed from 0.187 inches to 0.250 inches, and a 0.250-inch orifice was installed in the overboard bleed duct. The test, redesignated test 5B, was completed satisfactorily on March 11. Quick-look data indicated nominal values for all monitored operating parameters. Test data from the accelerometer indicated that 140 g's were experienced on the first start, but no rough combustion cutoff was encountered. Rough combustion occurred for one second on the first firing only; the remaining four firings were smooth and normal.

Spacecraft 001

Installation and checkout of the helium vacuum subsystem were completed on February 16. The oxidizer sump tank tie-down bolts were replaced, and larger washers were added to increase the bearing surface of the tank skirt.

An oxidizer leak was encountered at the electrical connector for the oxidizer sump tank probe. The oxidizer leaked past the structural bond of the probe to the connector. The probe was removed and a cover plate was installed.

The second test firing (two 30-second firings separated by an interval of 5 minutes) of the first test series with spacecraft 001 was attempted on March 6 but was discontinued because of repeated rough combustion cutoff signals. The orifice resizing and the increased rough combustion cutoff subsystem limits, used successfully with test fixture F-2, were incorporated as a result of the rough combustion cutoff signals. The second firing was accomplished satisfactorily on March 13. Propellant mixture ratios appeared to be satisfactory. An increased actuator opening rate and a decreased closing rate were experienced as a result of the actuator orifice changes.

FLORIDA FACILITY

Boilerplate 26

Buildup of the launch escape subsystem (LES) for boilerplate 26 was initiated with delivery of the LES components to the pyrotechnic installation building on February 17. Electrical continuity checkout of the wire harnesses was completed on February 19. The pre-installation inspection of the launch escape tower jettison motor was accomplished on February 24. The launch escape tower and launch escape motor were mated on February 26. The tower jettison motor was mated with the pitch control motor support structure and nose cone on March 1.

The two tower sequencers were installed on March 4 in preparation for bonding of the wire harnesses to the launch escape motor. The first wire harness was bonded to the motor on March 9, and the second wire harness was bonded to the motor on March 10. The second coat of bonding material was applied on March 12.

FACILITIES

DOWNEY

Quality Verification Vibration Testing

Basic Electrodynamic Vibration Subsystem

Initial tests on the amplifier were successful, and final acceptance tests began during the report period.

Work Stands and Bases

Station 7A (command module and service module work stands) is ready to accept spacecraft 006. The station was fully completed on March 12, 1965.

Radio Frequency Transmission Lines, System Integration and Checkout Facility

Stand 2A was completed and tested on March 5. Installation of the cable tray was completed on Stand 2B on March 8, and testing of the remaining stands was completed March 12.

Addition to System Integration and Checkout Facility

All structural steel erection and bolt-up is complete. Installation of metal roof decking is complete, and work has started on sheet metal siding.

APPENDIX

S&ID SCHEDULE OF APOLLO MEETINGS AND TRIPS

S&ID Schedule of Apollo Meetings and Trips
February 16 to March 15, 1965

Subject	Location	Date	Organization
Scientific experiments for spacecraft 012, discussion	Houston, Texas	Feb. 16 to 19	S&ID, NASA
Performance criteria, spacecraft 009	Minneapolis, Minnesota	Feb. 16 to 19	S&ID, Honeywell
Engineering drawing requirements, integrated system schematics	Houston, Texas	Feb. 17 to 19	S&ID, NASA
Technical coordination meeting	San Diego, California	Feb. 15 to 17	S&ID, NASA, General Dynamics Convair
Monthly technical interchange meeting	Lowell, Masachusetts	Feb. 15 to 19	S&ID, Avco
Cryogenic storage subsystem meeting	Boulder, Colorado	Feb. 17 to 19	S&ID, Beech
Design review meeting	Palo Alto, California	Feb. 17 to 18	S&ID, Philco
Coordination meeting, technical	Houston, Texas	Feb. 17 to 18	S&ID, NASA
Specification negotiations meeting	Houston, Texas	Feb. 18 to 20	S&ID, NASA
ACE checkout tapes, discussion	Houston, Texas	Feb. 18 to 19	S&ID, NASA
Block II design meeting	Minneapolis, Minnesota	Feb. 21 to 25	S&ID, Honeywell
Engineering supervision for field repairs	Huntsville, Alabama	Feb. 21 to 24	S&ID, NASA
AGC program change requirements	Cambridge, Massachusetts	Feb. 22 to 25	S&ID, MIT
Manual thrust vector control simulation study	Minneapolis, Minnesota	Feb. 22 to 26	S&ID, Honeywell
Review and evaluation of ground support equipment	Sacramento, California	Feb. 22 to 23	S&ID, Aerojet
Coordination meeting, service module RCS thermal control design	Houston, Texas	Feb. 22 to 23	S&ID, NASA
Block I EMI specification review	Cedar Rapids, Iowa	Feb. 22 to 26	S&ID, Collins
Monthly service propulsion subsystem meeting	Houston, Texas	Feb. 23 to 24	S&ID, NASA
Evaluation of docking vision and lighting simulation	Houston, Texas	Feb. 23 to 25	S&ID, NASA
Instrumentation and communications panel meeting	Huntsville, Alabama	Feb. 24 to 26	S&ID, NASA

S&ID Schedule of Apollo Meetings and Trips
February 16 to March 15, 1965 (Cont)

Subject	Location	Date	Organization
Ground support equipment review meeting	Sacramento, California	Feb. 22 to 24	S&ID, Aerojet
Review of Apollo mission simulator programming	Pleasantville, New York Binghamton, New York	Feb. 19 to Mar. 5	S&ID, Link
Review of effects of low-frequency vibration on boilerplate 23 flight test	Houston, Texas	Feb. 28 to Mar. 1	S&ID, NASA, General Dynamics Convair
Coordination meeting, qualification drop test	El Centro, California	Feb. 28 to Mar. 27	S&ID, USN
Design interface working group meeting	Bethpage, L. I., New York	Mar. 1 to 3	S&ID, Grumman
Handling and assembly of boilerplate 27	Huntsville, Alabama	Mar. 2 to 7	S&ID, NASA
Command-service module-lunar excursion module modal testing	Houston, Texas	Mar. 2 to 4	S&ID, NASA
Management review meeting	Minneapolis, Minnesota	Mar. 3 to 5	S&ID, Honeywell
Review subsystem procurement specifications	Cedar Rapids, Iowa	Mar. 3 to 5	S&ID, Collins
Discussion of block diagrams to support critical design review 2	Houston, Texas	Mar. 3 to 7	S&ID, NASA
Monthly program management meeting	Houston, Texas	Mar. 3 to 4	S&ID, NASA
Fuel cell acceleration qualification test	Bohemia, L. I., New York	Mar. 7 to 12	S&ID
Contract change negotiations, fuel cell	East Hartford, Connecticut	Mar. 7 to 12	S&ID, Pratt & Whitney
Establishment of SCS Block II design base	Minneapolis, Minnesota	Mar. 7 to 12	S&ID, Honeywell
Performance requirements meeting	Houston, Texas	Mar. 8 to 9	S&ID, NASA
Management heat shield coordinating meeting and briefing	Lowell, Massachusetts	Mar. 8 to 11	S&ID, Avco
Management review meeting	Minneapolis, Minnesota	Mar. 9 to 11	S&ID, Control Data
Present status report on mission duration for spacecraft 012, electrical power requirements for spacecraft 011, Block II power control program	Houston, Texas	Mar. 10 to 12	S&ID, NASA

S&ID Schedule of Apollo Meetings and Trips
February 16 to March 15, 1965 (Cont)

Subject	Location	Date	Organization
Briefing on minimum temperature for Block I heat shield	Houston, Texas	Mar. 10 to 12	S&ID, NASA
Interpretation of requirements in spacecraft 009 specification	Cocoa Beach, Florida	Mar. 10 to 12	S&ID, NASA, General Electric
Review of schedule slippage and associated hardware delivery dates, SPS	Sacramento, California	Mar. 11	S&ID, Aerojet
EDS working group	Huntsville, Alabama	Mar. 11 to 13	S&ID, NASA
Review of Honeywell Block II engineering and reliability program	Minneapolis, Minnesota	Mar. 13 to 19	S&ID, Honeywell
Total schedule review, hydrogen and oxygen tanks	Boulder, Colorado	Mar. 14 to 16	S&ID, Beech
Subcontractor management coordination meeting	Minneapolis, Minnesota	Mar. 14 to 23	S&ID, Honeywell
Ground development test working group meeting	Houston, Texas	Mar. 14 to 17	S&ID, NASA
Saturn/Apollo electrical systems integration panel meeting and discussion	Cocoa Beach, Florida	Mar. 14 to 18	S&ID, NASA
Discussion of hardware and visual cue requirements for command and service module docking study	Newport News, Virginia	Mar. 14 to 17	S&ID, NASA
Qualification test problems	Huntington, Indiana	Mar. 14 to 16	S&ID, Model Engineering
Qualification test procedure problems	Newark, New Jersey	Mar. 17 to 19	S&ID, Weston
Witnessing of acceptance test, discussion of equipment problems	Cedar Rapids, Iowa	Mar. 14 to 16	S&ID, Collins
ICD subpanel meeting	Cocoa Beach, Florida	Mar. 14 to 17	S&ID, NASA
On-site monitoring of ablation tests	Mountain View, California	Mar. 15 to 18	S&ID, Ames
Witness arc jet design verification tests and review of qualification test failures	Lowell, Massachusetts	Mar. 15 to 18	S&ID, Avco
Review and discussion of changes in the qualification test program	San Carlos, California	Mar. 15 to 17	S&ID, Pelmec
Technical support, electromagnetic compatibility of Block II SCS	Minneapolis, Minnesota	Mar. 15 to 26	S&ID, Honeywell
SPS engine test review	Sacramento, California	Mar. 15 to 16	S&ID, Aerojet